

REMARKS

Claims 1, 12, 19, 33 and 38-41 have been amended, and claims 4, 7, 23 and 26 have been cancelled without prejudice or disclaimer of the subject matter recited therein. No new matter is presented in this Amendment. Proper support for the amendments to the claims can be found in the specification, at least at Table 1 and paragraphs [0037] through [0043] of the specification.

REJECTIONS UNDER 35 U.S.C. §112:

Claims 1, 4, 7-16, 19, 20, 23, 26, 32, 33 and 36-41 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement.

Applicants have amended independent claims 1, 12, 19, 33 and 38-41 to correct the minor informalities noted by the Examiner. Accordingly, Applicants respectfully submit that claims 1, 12, 19, 33 and 38-41 fully comply with the requirements of 35 U.S.C. §112, first paragraph and therefore respectfully request that the rejection of the claims be withdrawn.

Claims 8-11, 13-16, 20 and 32 were rejected because of their dependency from independent claims 1, 12 and 19. However, since independent claims 1, 12 and 19, as amended, fully comply with the requirements of 35 U.S.C. §112, first paragraph, Applicants therefore respectfully request that the rejection of claims 8-11, 13-16, 20 and 32 under 35 U.S.C. §112, first paragraph be withdrawn.

Claims 4, 7, 23 and 26 have been cancelled without prejudice or disclaimer of the subject matter recited therein, accordingly, the rejection of these claims is moot.

REJECTIONS UNDER 35 U.S.C. §103:

Claims 1, 4, 7-16, 19, 20, 23, 26, 32, 33 and 36-41 are rejected under 35 U.S.C. §103(a) as being unpatentable over Evans et al., (U.S. Patent 4,302,520).

Applicants respectfully traverse this rejection for at least the following reason.

Regarding the rejection of independent claims 1 and 19, it is noted that claims 1 and 19,

as amended, recite a lithium sulfur battery and an electrolyte for use in a lithium sulfur battery comprising, amongst other novel features, a weak polar solvent having a dielectric coefficient of less than 15 and comprising dimethoxyethane, a strong polar solvent comprising sulfolane, and a lithium protection solvent comprising 1,3-dioxolane, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Evans discloses a non-aqueous cell utilizing an active metal anode, a cathode and a liquid organic electrolyte such as 3-methyl-2-oxazolidone in conjunction with a solvent and a selected solute (column 1, lines 7-14). The solvents used by Evans include cyclic ethers such as tetrahydrofuran and 1,3 dioxolane; monoethers such as diethyl ether; and cyclic sulfones such as sulfolane and others (column 4, lines 28-35). Therefore, Evans discloses weak polar solvents, strong polar solvents and lithium protection solvents. However, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1. Furthermore, Evans fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15, as recited in independent claims 1 and 19.

Accordingly, Applicants respectfully assert that the rejection of independent claims 1 and 19 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claims 1 and 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 8-11 and 36 and 20 and 32 are allowable at least because of their dependence from claims 1 and 19, respectively, and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 8-11 and 36 and 30 and 32 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising three different solvents, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein the weak polar solvent comprises dimethoxyethane, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1, 3-dioxolane, and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest the volume ratio of the mixed organic solvents, and in particular, Evans fails to teach or suggest a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte comprise at least three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface; and placing the electrolyte between the positive and negative electrode using a separator to form the lithium-sulfur battery, wherein the weak polar solvent has a dielectric coefficient of less than 15 and comprises dimethoxyethane, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest any method of manufacturing a lithium-sulfur battery. Furthermore, Evans fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15 and comprises dimethoxyethane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 33, as amended.

Regarding the rejection of independent claim 38, it is noted that claim 38 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising a weak polar solvent, first and second strong polar solvents, and a lithium protection solvent, wherein the weak polar solvent comprises dimethoxyethane, the first strong polar solvent comprises sulfolane, the second strong polar solvent comprises dimethylsulfoxide, and the lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest volume ratios of the mixed organic solvents. In particular, Evans fails to teach or suggest that the volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10, as recited in independent claim 38.

Accordingly, Applicants respectfully assert that the rejection of independent claim 38 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 38, as amended.

Regarding the rejection of independent claim 39, it is noted that claim 39 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, wherein the first weak polar solvent comprises dimethoxyethane, the second weak polar solvent comprises methyltetrahydrofuran, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10.

As noted above, although Evans discloses strong and weak solvents and a lithium

protection solvent, Evans fails to teach or suggest mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, and wherein a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10.

Accordingly, Applicants respectfully assert that the rejection of independent claim 39 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 39, as amended.

Regarding the rejection of independent claim 40, it is noted that claim 40 recites mixed organic solvents comprising a weak polar solvent, a strong polar solvent, and first and second lithium protection solvents, wherein the weak polar solvent comprises dimethoxyethane, the first lithium protection solvent comprises 3,5-dimethylisoxazole, the strong polar solvent comprises sulfolane, and the second lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest that the weak polar solvent comprises dimethoxyethane, the first lithium protection solvent comprises 3,5-dimethylisoxazole, the strong polar solvent comprises sulfolane, and the second lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1, as recited in independent claim 40.

Accordingly, Applicants respectfully assert that the rejection of independent claim 40 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 40, as amended.

Regarding the rejection of independent claim 41, it is noted that claim 41 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, wherein the first weak polar solvent comprises dimethoxyethane, the second weak polar

solvent comprises diglyme, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1:5.

As noted above, although Evans discloses strong and weak solvents and a lithium protection solvent, Evans fails to teach or suggest that the weak polar solvent comprises dimethoxyethane, the second weak polar solvent comprises diglyme, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1:5.

Accordingly, Applicants respectfully assert that the rejection of independent claim 41 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 41, as amended.

Claims 1, 4, 7-16, 19, 20, 23, 26, 32, 33 and 36-41 are rejected under 35 U.S.C. §103(a) as being unpatentable over Vourlis (U.S. Patent 5,432,030).

Applicants respectfully traverse this rejection for at least the following reasons.

Regarding the rejection of independent claims 1 and 19, it is noted that claims 1 and 19, as amended, recite a lithium sulfur battery and an electrolyte for use in a lithium sulfur battery comprising, amongst other novel features, a weak polar solvent having a dielectric coefficient of less than 15 and comprising dimethoxyethane, a strong polar solvent comprising sulfolane, and a lithium protection solvent comprising 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Vourlis discloses an electrochemical cell employing an electrolyte comprising a mixture of 3-methyl-2-oxazolidone in a range of 27 to 33 percent by volume and a volume ratio of 1,3-dioxolane to 1,2-dimethoxyethane (abstract). Therefore, Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, Vourlis fails to teach or suggest that the weak polar solvent has a dielectric coefficient of less than 15 and comprising dimethoxyethane, or that the strong polar solvent comprises sulfolane. Vourlis further fails to teach or suggest that the volume ratio of the weak polar solvent

to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claims 1 and 19.

Accordingly, Applicants respectfully assert that the rejection of independent claims 1 and 19 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claims 1 and 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 8-11 and 36 and 20 and 32 are allowable at least because of their dependence from claims 1 and 19, respectively, and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 8-11 and 36 and 30 and 32 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising three different solvents, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein the weak polar solvent comprises dimethoxyethane, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1, 3-dioxolane, and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, as also noted above, Vourlis fails to teach or suggest that the weak polar solvent comprises dimethoxyethane, or that the strong polar solvent comprises sulfolane. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include

additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte comprise at least three different solvents, a weak polar solvent, which is capable of dissolving elemental sulfur, a strong polar solvent, which is capable of dissolving lithium polysulfide, and a lithium protection solvent, which forms a good protective layer on a lithium surface; and placing the electrolyte between the positive and negative electrode using a separator to form the lithium-sulfur battery, wherein the weak polar solvent has a dielectric coefficient of less than 15 and comprises dimethoxyethane, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

As noted above, Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, as also noted above, Vourlis fails to teach or suggest that the weak polar solvent comprises dimethoxyethane, or that the strong polar solvent comprises sulfolane. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 33, as amended.

Regarding the rejection of independent claim 38, it is noted that claim 38 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising a weak polar solvent, first and second strong polar solvents, and a lithium protection solvent, wherein the weak polar solvent comprises dimethoxyethane, the first strong polar solvent comprises sulfolane, the second strong polar solvent comprises dimethylsulfoxide, and

the lithium protection solvent comprises 1,3-dioxolane, and a volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10.

Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, as also noted above, Vourlis fails to teach or suggest that the strong polar solvent comprises sulfolane. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the first strong polar solvent to the second strong polar solvent to the lithium protection solvent is 20:16:4:10, as recited in independent claim 38.

Accordingly, Applicants respectfully assert that the rejection of independent claim 38 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 38, as amended.

Regarding the rejection of independent claim 39, it is noted that claim 39 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, wherein the first weak polar solvent comprises dimethoxyethane, the second weak polar solvent comprises methyltetrahydrofuran, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10.

Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, Vourlis fails to teach or suggest first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 16:4:20:10, as recited in independent claim 39.

Accordingly, Applicants respectfully assert that the rejection of independent claim 39 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 39, as amended.

Regarding the rejection of independent claim 40, it is noted that claim 40 recites mixed organic solvents comprising a weak polar solvent, a strong polar solvent, and first and second lithium protection solvents, wherein the weak polar solvent comprises dimethoxyethane, the first lithium protection solvent comprises 3,5-dimethylisoxazole, the strong polar solvent comprises sulfolane, and the second lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1.

Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, Vourlis fails to teach or suggest a weak polar solvent, a strong polar solvent, and first and second lithium protection solvents. Vourlis further fails to teach or suggest the volume ratios of the solvents and in particular, Vourlis fails to teach or suggest that the volume ratio of the weak polar solvent to the first lithium protection solvent to the strong polar solvent to the second lithium protection solvent is 4:1:4:1, as recited in independent claim 40.

Accordingly, Applicants respectfully assert that the rejection of independent claim 40 under 35 U.S.C. §103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 40, as amended.

Regarding the rejection of independent claim 41, it is noted that claim 41 recites a lithium-sulfur battery comprising, amongst other novel features, mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent, wherein the first weak polar solvent comprises dimethoxyethane, the second weak polar solvent comprises diglyme, the strong polar solvent comprises sulfolane, and the lithium protection solvent comprises 1,3-dioxolane, and wherein a volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1:5.

Vourlis discloses an electrolyte comprising a strong polar solvent, a weak polar solvent and a lithium protection solvent. However, Vourlis fails to teach or suggest, mixed organic solvents comprising first and second weak polar solvents, a strong polar solvent, and a lithium protection solvent. Vourlis further fails to teach or suggest the volume ratios of the solvents and

in particular, Vourlis fails to teach or suggest that the volume ratio of the first weak polar solvent to the second weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1:5, as recited in independent claim 41.

Accordingly, Applicants respectfully assert that the rejection of independent claim 41 under 35 U.S.C. §103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 41, as amended.

CONCLUSION:

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 503333.

Respectfully submitted,

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